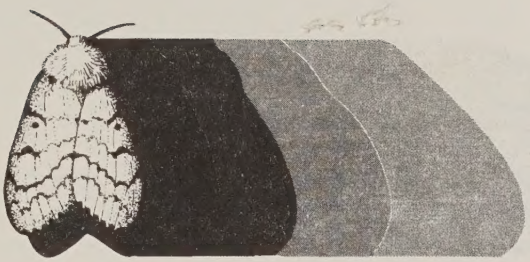

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GYPSY MOTH NEWS

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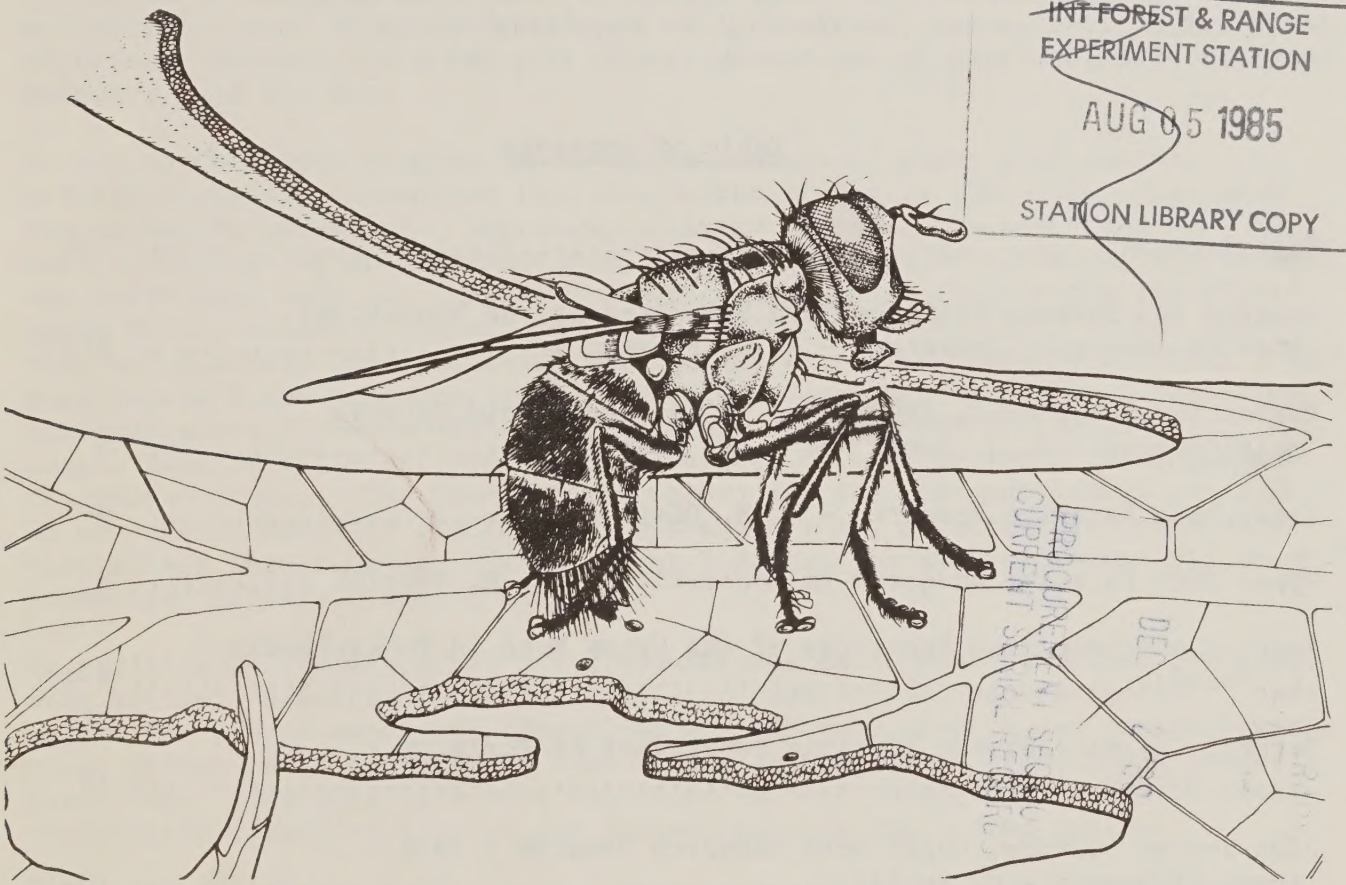
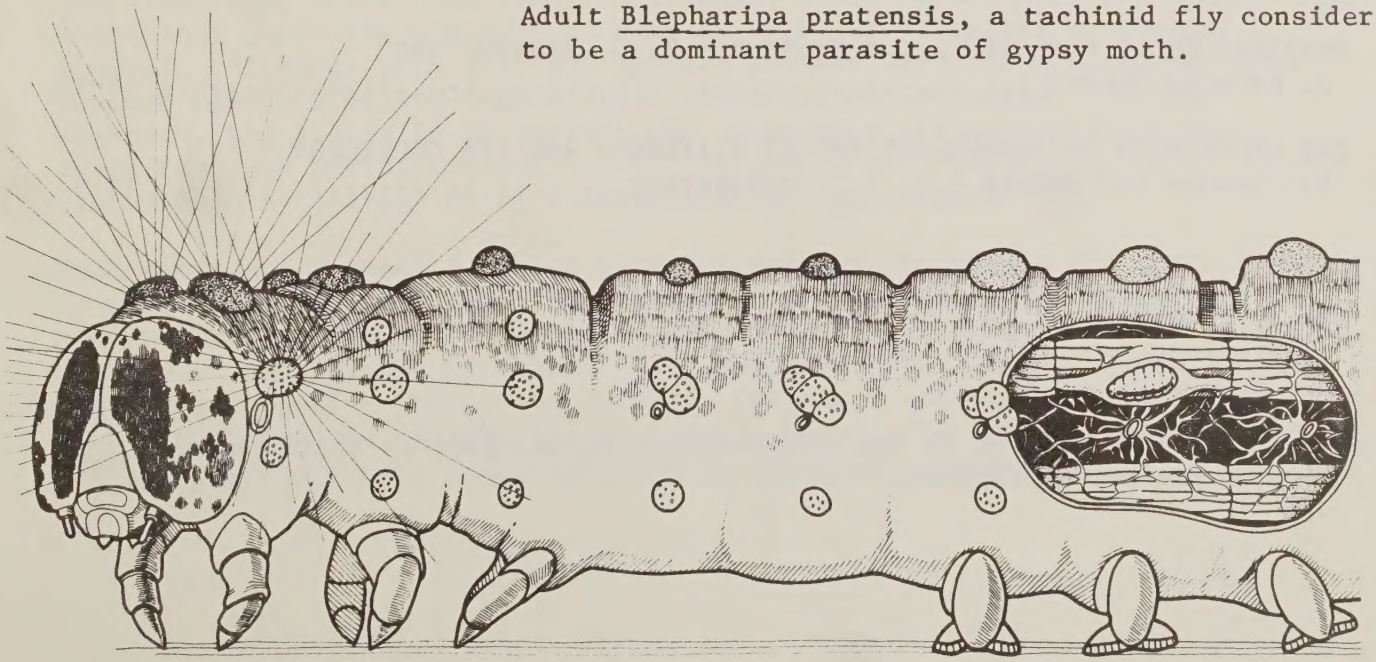


Adult Blepharipa pratensis, a tachinid fly considered to be a dominant parasite of gypsy moth.



B. pratensis maggot within a gypsy moth host.

GYPSY MOTH NEWS FOCUS ON PARASITES - RESEARCH, REARING AND RELEASE[1/]

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1/ We encourage anyone to use this information as part of their gypsy moth education programs.

Cover: Line drawings courtesy USFS, Hamden, CT.

The attempted use of parasites to control gypsy moth in the United States represents one of the most extraordinary efforts in the history of biological control. Since 1905 gypsy moth parasites have been collected in Europe, the Middle East, Japan, India and the Soviet Union and forwarded to the United States for release. Numerous agencies have been involved starting with the State of Massachusetts, and including the Pennsylvania Bureau of Forestry, New Jersey Department of Agriculture, North Carolina Department of Agriculture, Virginia Department of Agriculture, Maryland Department of Agriculture, West Virginia Department of Agriculture, Connecticut Agricultural Experiment Station, University of Maine, University of Maryland, University of Delaware, and the USDA.

On the surface, the problem of parasitic control of gypsy moth appears straightforward. Introduced into the United States in 1869, the gypsy moth had no native parasites. Beginning actively in 1905, the study and introduction of natural enemies from Europe and Japan into the United States was undertaken with the expressed intent to establish these parasites within gypsy moth population centers occurring in the United States. It was believed that establishing these parasites would lead to the maintenance of gypsy moth populations below damaging levels. The introduction of gypsy moth parasites occurred generally from 1905-1933, and resumed again during the 1960's. In total, over 80 different species of parasites were collected and shipped to the United States. The Hymenoptera (wasps) are the dominant insect order both in numbers of parasite species and in frequency and effectiveness with which they attack insect pests. In the order Diptera, the Tachinidae are the most beneficial parasitic family of flies.

In addition to the dipterous and hymenopterous parasites introduced for gypsy moth control, nematode parasites have also been studied and collected. These parasites, though sometimes classified as pathogens, attack and interact with their insect hosts in much the same manner as other more traditional insect parasites. Nematodes have been collected in both Europe and Japan, to date with little promising results for introduction to the United States.

The discovery, study, importation, release, and establishment of exotic species of parasites are part of what is known as classical biological control. Although this approach appears to have been the most successful, another approach called augmentation has also been employed. In this approach, the theory is to augment the parasite's effectiveness by mass production and periodic colonization (including the redistribution of already established parasites) or by planned genetic improvement.

What about the success of these parasite release programs? There are probably as many opinions concerning the success of parasite establishment for gypsy moth control as there are people working in these programs. To date, several species of once exotic parasites are considered established. These include Anastatus disparis, Ooencyrtus kuwanai, Cotesia (= Apanteles) melanoscelus, Phobocampe disparis, Blepharipa pratensis, Compsilura concinnata, Exorista larvarum, Parasetigena silvestris and Brachymeria intermedia.

The effect that these established parasites have had upon gypsy moth populations remains largely undocumented. It is an issue clouded by a definition of "success" and the "control" expectations of pest management specialists.

Recently, the Gypsy Moth News asked several experts in the field of parasite importation, rearing and release, to comment upon their current programs. We have reprinted here the responses received. Recognizing that all of the pertinent information about these programs cannot be included in the Gypsy Moth News, readers are urged to contact the investigators themselves for more specific descriptions.

In addition, background information about gypsy moth parasites, their collection, rearing, and release can be found in: The Gypsy Moth Research Toward Integrated Pest Management, USDA Expanded Gypsy Moth Research and Development Program, Forest Service SEA Technical Bulletin 1584, published in 1981 (Charles Doane and M. McManus, eds.) 1/

The first 4 articles to follow are from research entomologists heavily involved with gypsy moth parasite research, rearing and release. The second 2 are from State survey entomologists involved with operational pest management programs.

These responses are not intended to summarize all of the current gypsy moth parasite work, rather they provide an overview of some of the work currently underway in the East.

1/Copies of this book can be obtained by contacting the USDA Forest Service, 370 Reed Road, Broomall, PA 19008.

Rearing and Release of Gypsy Moth Parasites at the Beneficial Insects Research Laboratory Newark, Delaware

Roger W. Fuester

Dr. Fuester is a research entomologist with the USDA Agricultural Research Service, Beneficial Insects Research Laboratory, 501 S. Chapel Street, Newark, Delaware 19713.

Biological control of insects pests using natural enemies (parasites, predators, and pathogens) has been very successful in a number of projects, both for agricultural crops and forests. There are two basic approaches used in biological control: 1) The so-called classical approach is directed at biological control of insect pests introduced from one continent into another

by means of importations of those species of natural enemies that attack the pests in their home countries. 2) The manipulative approach, which is usually directed against native insect pests, involves the utilization and maximization of those species of natural enemies that are already present in the crop or forest ecosystem, and may encompass several tactics. Most often it involves augmentative release of natural enemies so as to boost their numbers and impact on the target pest. Other strategies include provision of supplementary food or nesting shelters for natural enemies, or alteration of cultural practices so as to increase the survival of natural enemies. Over the years, the Beneficial Insects Research Laboratory (BIRL) has been involved primarily with classical type biological control projects, since we have a quarantine facility which is necessary for safe importation of natural enemies.

Substantial efforts at classical biological control of the gypsy moth were made by introducing natural enemies, mostly from Europe, earlier in the century, especially during the years 1905-1914 and 1922-1933. As a result of these early importations, one predator and ten species of parasites became established. These introduced natural enemies, primarily parasites, tend to retard gypsy moth outbreaks and reduce their severity, but cyclic population explosions still occur. Because past records of classical biological control projects demonstrate that improved results frequently accrue from multiple species introductions, importation work was resumed, both at BIRL and elsewhere, in an effort to obtain establishment of additional species of natural enemies during the 1970's. Because previous work involved primarily importations of parasites from Europe, present emphasis is on introduction of material from Asia. Since 1975, more than a dozen species of parasites have been imported from Japan, China, Korea, and India.

Shipments of natural enemies arriving from overseas are opened and examined in quarantine to prevent the accidental introduction of phytophagous insects, hyperparasites (parasites that attack parasites), or other undesirable organisms. After passing through quarantine, the insects may be released in the field, cultured for eventual release, or shipped to cooperators for release or culture. Because the adjoining states of Maryland, New Jersey, and Pennsylvania all have their own gypsy moth parasite programs, we at BIRL have been making releases in Delaware, but have also provided shipments of parasites for release to cooperators in states which do not have programs on a limited basis. At present, we are rearing and releasing five Asian parasites for colonization.

1) Glyptapanteles flavicoxis -- a gregarious (several individuals develop in a single host) parasite of medium-large gypsy moth larvae from India.

2) Hyposoter lymantriae -- a solitary (only one individual develops on a single host) parasite of small gypsy moth larvae from India.

3) Casinaria arjuna -- a solitary parasite of small gypsy moth larvae from Korea.

4) Meteorus pulchricornis -- a solitary parasite of small-medium gypsy moth larvae from Korea, This strain is peculiar in that it is uniparental, producing only females.

5) Cotesia melanoscela ("Halo") -- a solitary parasite of small-medium gypsy moth larvae from Korea. This strain differs from the European strain of C. melanoscela already established in the U.S. by having an extended "halo" of coarse silk surrounding its cocoon.

Because we are attempting to get exotic species established in a "new" environment, it is important to give the parasites released every chance for survival. Consequently, we cooperate closely with operational program managers in finding release sites (primarily low value and/or low use areas) which will not be sprayed during the season releases are made, and preferably the following year.

Of the dozen Asiatic parasites introduced since 1975, only one, a pupal parasite, Coccygomimus disparis, has become established. This species was recovered during 1983 and 1984 at several sites in Maryland and Pennsylvania. It is too soon to predict what the long-term impact of C. disparis will be on populations of the gypsy moth, but its population buildup and dispersal will be monitored at sites where it has been recovered. Because the gypsy moth has an extended range in North America, colonization over the generally infested area would enhance the biological control program by speeding up dispersal of C. disparis or any other species that becomes established. For the same reason, we feel that several parasite species which failed to become established in the northeastern U.S. should be released in other regions to which they may be better adapted as the gypsy moth spreads. In both cases, parasite releases would be coordinated with operational pest management programs so as to minimize the possibility of spraying in release areas.

Because most of my experience has been in classical biological control, I haven't touched on the possibilities for augmentative releases of those parasite species already established. Only a few augmentation studies have been tried in recent years, and this technique has not yet been shown to be an effective means of regulating populations of the gypsy moth in the U.S. However, this state of affairs may only be a consequence of our incomplete knowledge of parasite population dynamics. We know, for example, that rates of larval parasitism are generally low during the first two years of an outbreak, but rise to high levels during the first and second post-culmination year. However, we don't know what happens to the parasite population during the innocuous (latent) period between outbreaks. Therefore, we really can't tell when releases of parasites would do the most good. Thus, there is a clear need for long-term intensive observations on the parasite complex throughout a gypsy moth population cycle. Depending on the outcome of such studies, pest managers can expect to see some experimental releases of parasites during the latent period or early release (progradation) phase of the gypsy moth population cycle. If the experimental releases prove successful, then augmentative releases might become a growing aspect of gypsy moth pest management.

Estimating Total Mortality Caused by the Parasitoid *Cotesia melanoscelus*

Michael J. Raupp and Kevin W. Thorpe

Dr. Raupp is an Assistant Professor of Entomology at the University of Maryland, Department of Entomology, College Park, Maryland 20742. Mr. Thorpe is a former graduate student of Dr. Raupp.

The impact of insect parasitoids on gypsy moth populations in the United States has been a topic of much debate. One factor contributing to our lack of understanding concerning the effectiveness of parasitoids is our inability to assess the total amount of mortality they cause. Most estimates of parasitoid-related mortality include only those causes in which parasitisms results in the production of parasitoid progeny. However, several recent studies have demonstrated that parasitoids can cause additional host mortality that does not result in the production of progeny.

This mortality can be divided into two general categories. The first category occurs when parasitoids attack (=sting) hosts but do not oviposit in them. This type of mortality may occur during host feeding. A second category of mortality occurs when parasitoids attack and oviposit in hosts but produce no viable progeny. Several mechanisms can contribute to this phenomenon. First, a host may be stung once or several times (superparasitized) by a single species of parasitoid and die before any parasitoids successfully complete development. Similar mortality may occur in the case of multiple parasitism (i.e. when two parasitoid species utilize the same host). A third category of mortality occurs when parasitoids and hosts interact with pathogens and predators in such a way that their collective mortality is increased.

The study we report examined the effects of superparasitism on gypsy moth and parasitoid mortality. The parasitoid used in the study was the braconid *Cotesia melanoscelus*. Groups of first instar gypsy moth larvae were stung 1, 2, 3 or 4 times by *C. melanoscelus*. Survivorship of the gypsy moth and production of parasitoids was recorded.

We found that the proportion of larvae dying without producing parasitoid progeny increased with increasing numbers of stings. With only a single sting, gypsy moth mortality not resulting in parasitoid reproduction increased nearly 3-fold over mortality among unstung control larvae.

Cotesia melanoscelus causes significant mortality in addition to that which results in parasitoid reproduction. If the effects observed in the laboratory also occur in the field, then traditional estimates of *Cotesia*'s impact on gypsy moth mortality are likely to be too low. Current and future experiments investigate the relationships among host age, behavior, dietary stress and the total mortality caused by gypsy moth parasitoids. These experiments will provide a better understanding of the actual impact of parasitoids on the gypsy moth.

Gypsy Moth Parasite Research

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Research Goals and Objectives

The Forest Service's goal of research on gypsy moth is to gain the knowledge and develop the tools useful for extending the time between outbreaks of gypsy moth populations and, ultimately, to prevent outbreaks. Toward this goal, the objective of research on parasites is to increase our understanding of parasite interaction with the host so as to better utilize parasites in regulating gypsy moth populations. This includes development of pest management strategies that enhance parasite effectiveness.

In 1984, in cooperation with scientists from the University of Massachusetts, the University of Maryland, and the University of Vermont, studies were initiated to: (1) develop methods for sampling parasites in low density host populations, and (2) assess the actual impact parasites have on gypsy moths on a generational basis and, in particular, the role of parasitism in low density gypsy moth populations. Results of these studies will provide information for identifying parasites with greatest potential for regulating gypsy moth populations and for evaluating pest management strategies for enhancing parasite effectiveness (i.e., augmentation, forest management, microbial interaction).

Concurrent with the studies noted above, research at the Forest Service's Hamden Laboratory is continuing to investigate (1) the chemical and behavioral basis for host selection by gypsy moth parasites (currently *Blepharipa pratensis* and *Ooencyrtus kuvanae*), (2) methods for rearing parasites, particularly those usually associated with low density, building gypsy moth populations (currently *B. pratensis*), (3) the "fitness" qualities associated with parasite establishment and effectiveness (i.e., functional response, diapause, survival) (currently *Rogas lymantriae* and *B. pratensis*), and (4) the relationship between gypsy moth parasites and pathogens so as to increase their effectiveness (currently *B. pratensis* and *R. lymantriae*). In addition, continued support and encouragement is being given to the evaluation, collection, importation, and establishment of the most promising exotic species.

Research Efforts in Cooperation with Operational Program

In 1978, B. pratensis was reared and released (augmentative) in low density gypsy moth populations at two locations in New Jersey. Results indicated the release was effective in augmenting the B. pratensis population as measured by significant increase in parasitism in the year following release. Using information gained in this initial release, and subsequent research on rearing and host selection, a prospectus for rearing and release of B. pratensis adult females was developed for the Maryland IPM area (1982-83). Plans are still in progress to make this an operational program.

Rogas lymantriae has been under continuous culture at the forest Service's Hamden Laboratory since 1978. To date, release for establishment has been made in cooperation with Maryland, Virginia, Vermont, Pennsylvania, Delaware, Massachusetts and Connecticut. Although sites for release were selected on basis of host density, potential alternate hosts, and habitat, and initial parasitism of wild gypsy moths at almost all of these release sites was noted, R. lymantriae has not been recovered the year following release.

The Future Role of Parasite Research, and Rearing/Release Operational Programs

Clasically, gypsy moth parasite rearing and release operational programs have given priority to species that can be easily reared, and releases have been made, primarily in areas where gypsy moths are abundant, with little attention being given to either the fitness of the reared insect to function in the forest, for the host and habitat characteristics which influence parasite establishment and/or effectiveness. There is now a significant base of knowledge on gypsy moth parasite behavior, primarily associated with host selection, that can be used in helping to make rearing-release decisions. However, we still lack essential information on habitat requirements, functional response, essential qualities for survival, and methods to evaluate total impact. In this latter category (total impact), recent studies have shown that percent parasitism significantly underestimates actual host mortality effected by parasite attack. Although this may not be surprising, current assessment of parasite impact, and decisions on rearing-release are based on percent parasitism.

Although past efforts in rearing and release of gypsy moth parasites does not appear to be entirely successful, from an operational point of view, the continued interest by State and Federal administrators for the development of biological control alternatives for regulating gypsy moth populations has continued to support parasite research. The results of these studies could, if utilized, contribute significantly to the development, management, and effectiveness of gypsy moth parasite rearing-release operational programs. There is still much information needed, but the present emphasis on research to manage low density-building gypsy moth populations offers the greatest potential for the future utilization of parasite release for augmentation or inundation ("paracide").

Gypsy Moth Parasite Research in Connecticut

Ronald M. Weseloh

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I am presently rearing four gypsy moth natural enemies, not to release them but to use in laboratory experiments. Specifically, I am investigating details of host selection in Cotesia melanoscelus, especially to see if there are any differences between a laboratory-adapted strain and field-collected insects. I am also interested in continuing work on selecting strains of C. melanoscelus which have desirable traits, such as ability to attack large caterpillars or rapid development. The hyperparasite, Eurytoma appendigaster,, which attacks C. melanoscelus cocoons, is being reared to study its host-selection behavior and I am looking at the reproductive diapause in the egg parasite, Ooencyrtus kuvanae. I am also trying to gain experience in rearing and overwintering the large carabid beetle, Calosoma sycophanta.

In field work, I am heavily committed to studying Calosoma sycophanta, especially how its behavior and population abundance changes as gypsy moth populations change and the impact of the beetle on the gypsy moth.

Concerning parasite releases, there are still many barriers to using this technique effectively. In the short run I think it likely that releases of some natural enemies can be shown to have significant impacts on gypsy moth populations, given sufficient commitment. Some studies have already come tantalizingly-close to showing this. However, actual, economically-sound pest management is a different matter, primarily because of the very high costs of rearing and (probably) distributing the agents. In order to make this technique feasible, developments which can now only be hinted at will be necessary. For instance, finding a cheap method of rearing parasites in vitro and/or discovering that releases need only be made in small "focal" areas would be very welcome discoveries indeed. I don't see these necessary developments occurring rapidly or leading to stunning breakthroughs that will solve all gypsy moth problems at once. But I believe that steady, long-term research could lead to good ways of using natural enemies. Time will tell.

Rearing and Releasing Parasites of the Gypsy Moth in Pennsylvania

Larry Rhoads

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History

Pennsylvania became involved in the gypsy moth parasite rearing business in 1968 through the efforts of the Pennsylvania Department of Agriculture, In 1972 responsibility for the biological control program was shifted to the Bureau of Forestry, a part of the Pennsylvania Department of Environmental Resources which had been newly created in 1971. Plans were developed, and by early 1974 a $500,000 Forest Pest Management facility was constructed which had over 14,000 square feet devoted to the insect rearing program. During the mid-1970's, the permanent staff allotment for the rearing operation included 17 technicians and one entomologist. The permanent staff was supplemented during the spring and summer with as many as 15 temporary positions. For the period 1973 through 1984, over $4.2 million were spent on the biological control program in Pennsylvania. This figure reflects total biocontrol expenditures and not just insect rearing and release expenses.

As shown in Table 2, 22 different species plus 4 additional strains of gypsy moth parasites have been reared in our facility. The numbers reared for release vary from the 20 million plus specimens of Ooencyrtus kuvanae to about 1,700 specimens of Hyposoter lymantriae. A comprehensive listing of the numbers of specimens of all species released in Pennsylvania is available as a computer printout from the Beneficial Insects Research Laboratory, Newark, Delaware. The bulk of the species was reared on gypsy moth; however, some were produced on the greater wax moth and the salt marsh caterpillar.

Table 1. Exotic gypsy moth parasites reared in Pennsylvania - 1968-1985.

Order: Family	Species	Origin
Hymenoptera: Braconidae	Cotesia melanoscelus	Europe
	C. melanoscelus (=Apanteles ruidus)	India
	C. melanoscelus (Russian strain)	Russia
	C. melanoscelus (Korean = halo strain)	Korea
	C. schaeferi	Korea
	Glyptapanteles flavicoxis	India
	G. indiensis	India
	G. liparidis	Europe and Japan
	G. porthetriae	France
	Meteorus pulchricornis	France

Order: Family	Species	Origin
Hymenoptera: Ichneumonidae	Coccygomimus disparis	Japan and India
	C. instigator	Yugoslavia
	C. turionellae turionellae	India
	C. t. moraguesi	Morocco
	Hyposoter lymantriae	India
Hymenoptera: Encyrtidae	Ooencyrtus kuvanae	Europe
Hymenoptera: Chalcididae	Brachymeria euploeae (=B. lasus)	India
	B. intermedia	Europe
	B. lasus	Japan
Diptera: Tachinidae	Blondelia nigripes	Poland
	Compsilura concinnata	Europe
	Exorista japonica	Japan
	E. larvarum	Yugoslavia
	E. segregata	Spain
	Palexorista disparis	India
	P. inconspicua	France

Philosophy

The primary objective of the parasite rearing program in Pennsylvania is to increase the number of components contained in the natural control complex currently established against the gypsy moth. To date we have established one new parasite, Coccygomimus disparis, in the Commonwealth. In addition, there has been some unmeasurable effect on enhancing the numbers of certain previously established exotics, such as Brachymeria intermedia, Ooencyrtus kuvanae, Cotesia melanoscelus, and Compsilura concinnata.

With the exception of a few small tests, we have never established an objective of conducting innundative releases. Rather, until 1984, many small- to moderate-size releases of a species were made scattered throughout the infested portion of the state. In 1984 this policy was changed so that currently larger (1,000+) releases are made in fewer permanent sites. Recent research has shown this technique gives the parasites a better chance of establishment, and it also simplifies our job of monitoring for establishment.

As has been done since starting the rearing program, a species is reared and released for three years. If, after three years, no evidence of establishment is found, the species is dropped from production. Before 1984, release sites would be occasionally monitored after the three-year release window, but only on a time-permitting basis. With the new system of permanent release and monitoring plots, monitoring will continue annually for the duration of the program.

A somewhat intangible benefit of the rearing program has been the overall positive public relations impact it has had on the citizens of Pennsylvania, especially the environmentally conscious ones. Although this was never established as a formal objective of the program, it is certainly something for a state contemplating entry into a biocontrol program to consider. Keep in mind there are certain pitfalls--all of the "friendly fly" nuisance problems are blamed on the program.

Current Status

At present, because of personnel cutback mandates and a lack of new parasite species from overseas, Pennsylvania's program is only a remnant of what it used to be. Our staff now consists of three permanent technicians and one entomologist and utilizes only about 4,000 square feet of rearing space. Fortunately, the problems have been only with personnel reductions and not with budget restrictions. We are able to meet our equipment and supply needs without any difficulty.

For 1985 we are rearing the following:

Cotesia melanoscelus (Korean strain)	- 25,000
C. melanoscelus (Russian strain)	- 25,000
C. schaeferi	- 100,000
Hyposoter lymantriae	- 10,000

Over the years, the number of species of exotic parasites being made available to Pennsylvania for rearing has steadily decreased. In 1984 only one shipment was received, and that was of a species we were currently rearing.

A positive benefit of the present situation is that we are able to devote more effort to methods improvement projects and, as a result, are releasing, based upon size, sex ratio, and lab-to-field mortality, the best parasites ever.

Future

We are planning to continue our exotic parasite rearing and release program as long as any new species or strains are made available. Because of a top-level management plan to consolidate all Harrisburg area DER facilities into a central location, the program will in all probability be moving into new quarters by 1987. We hope to have 4,000-5,000 square feet of more sophisticated lab space available. However, this new lab space is not destined solely for "bug factory" work. Rather, its primary function will be to serve as lab support for a variety of biocontrol-related field studies. This fits in with our plans to shift focus from the mass rearing and release of exotic parasites to learning more about the established natural control in Pennsylvania.. Hopefully, we will be able to learn enough to someday be able to implement a true IPM program for the gypsy moth.

Parasite Release by the Virginia Department of Forestry

C. L. Morris

Mr. Morris is Chief of the Insect and Disease Investigations Branch of the Virginia Department of Conservation and Economic Development, Box 3758, Charlottesville, Virginia 22903.

1. We have released a large number of parasites in the years before the gypsy moth was known to be established in Virginia during the early 70's. These were supplied by the USDA and the Cooperative Parasite Program and included those reared in our own facilities. The objective was to establish on alternate natural hosts, those parasites that looked promising prior to gypsy moth establishment. That objective continued throughout the parasite rearing and release efforts by the Division. There were no efforts to inundate or flood the area with large numbers of parasites; rather we tried to establish small colonies throughout the area of Northern Virginia for the most part.

2. The program consisted of one part-time individual in the rearing lab at Charlottesville. Distribution of the parasites supplied by the USDA was supported by several part-time summer time helpers.

3. Accomplishments: We have determined that early releases of Compsilura concinnata were successful in several areas of the state, since we were able to recover that parasite in the release areas in the years that followed at least on three different locations. Periodic efforts in the years that followed initial releases failed to show the establishment of any of the other parasites that were released, although sporadic and periodic attempts of recovery from native pests were made. Glyptapanteles flavicoxis were also recovered in Northern Virginia in 1983 and again in 1984 following releases.

4. Release success, of course, is measured by the degree of recovery. The Division has not conducted an organized recovery effort but each year has made efforts to collect and rear native insects and gypsy moths when they did appear for parasite recovery. These recovery efforts were confined for the most part in Northern Virginia in recent years.

5. Plans for the future include a continued effort to introduce any new or promising parasites or strains thereof which might become available from the USDA. In 1985 we are conducting a small scale rearing program with the Russian Strain of Cotesia melanoscela for the purpose of establishing this parasite in the areas where gypsy moth is active in Northern Virginia.

USDA Forest Service, Gypsy Moth Research Program
1984 Accomplishments

Dr. G. Hertel
USDA Forest Service, NE Experiment Station
Broomall, PA

Research Update. Here are the parasite related accomplishments for the first year of the USDA Forest Service Northeastern Forest Experiment Station/University cooperative gypsy moth research program. For more information about this aspect of the Research Program, contact Dr. Tom Odell, USDA Forest Service, Northeast Station,51 Mill Pond Rd., Hamden, CT.

Research on parasitism of the gypsy moth was directed toward understanding the actual impact parasites have on gypsy moths on a generational basis, and in particular, the role of parasitism in low density gypsy moth populations. In addition, studies were conducted to determine the chemical and behavioral basis of host selection, and in the development of methods for rearing, biological evaluation, and establishment of exotic parasitoids. (Cooperators: Univ. Mass.; Univ. Maryland; Univ. Vermont)

Recoveries of marked larvae yielded important information on the level of parasitoid input independent of the compensatory action of other mortality factors. By combining the measured input with the weekly estimated host density, estimates could be made of stage specific "generational" mortality caused by an particular parasite.

The studies using marked larvae also provide information that helps identify the most appropriate moments in the generation for which to obtain estimates of parasitoid impact. For example, at what physiological age of the host can percent parasitism be used to estimate the actual impact on the gypsy moth population.

Laboratory studies indicated that Cotesia melanoscelus could potentially cause higher levels of mortality in gypsy moth populations than would be indicated by determining rates of parasitization alone. Total mortality due to parasite attack was significantly higher than the classical rate of parasitism; i.e., percent parasitism as determined by emergence of the parasite from the host. Total mortality increased significantly with number of attacks per host.

Seven methods were tested for collecting gypsy moth larvae in low level populations. Early stage larvae utilized branch bands for resting sites and thus could be used for collecting larvae. This will be particularly useful in low density populations, and where search in the crown of large trees is limited by accessibility and time.

Results of studies to investigate the host selection behavior of Ooencyrtus kuvanae, an egg parasite of the gypsy moth, suggest that the parasite is unlikely to be effective when egg masses are primarily deposited in dark, hidden areas, a condition typical when gypsy moth population density is low. In the laboratory, parasites are attracted to egg masses located in both light and dark chambers. However, they appear to be inhibited from entering the dark chamber, aggregating instead outside the chamber.

Laboratory studies of Rogas lymantriae show that sex ratio of this parasite can be manipulated by changing the density of the host relative to density of parasite females. This is important for understanding parasite viability at various gypsy moth population densities, and in developing protocols for mass rearing. In addition, the R. lymantriae was released for establishment in two sites in Vermont and in Maryland Gypsy Moth IPM area.

Three thousand Blepharipa pratensis puparia were reared/collected for mass rearing and experimentation in 1985.

Maryland Gypsy Moth IPM Pilot Project

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In recent years interest has been growing in an alternative approach to pest control problems that minimizes chemical pesticide sprays. This approach has been termed IPM, which stands for Integrated Pest Management. IPM can be defined as a balanced approach to solving pest control problems in which all possible control tactics are evaluated on the basis of short and long term effectiveness, environmental safety and cost. Those tactics that best meet these criteria are then integrated into a management program to prevent pest levels from reaching thresholds that would result in severe tree mortality or human annoyance.

Recently Maryland was selected as the State in which a pilot gypsy moth IPM program should be implemented and evaluated. The Technical Committee selected to direct this project is composed of representatives from the following agencies: Maryland Department of Agriculture; Maryland Forest, Park and Wildlife Service; University of Maryland, Cooperative Extension Service; USDA, U. S. Forest Service, USDA, Agricultural Research Service; USDA, Animal Plant Health Inspection Service. The project area selected for this work includes about 75,000 hectares in Prince George's and Anne Arundel Counties as shown on the accompanying map. The primary objective of the Maryland gypsy

moth IPM project is to closely monitor gypsy moth populations annually, and to apply and evaluate selected, mostly nonchemical, control methods used in the project area that can maintain gypsy moth populations below economically damaging and annoying levels. The overall project will be evaluated at the end of 5 years by comparing the IPM area to a similar infested adjacent area that will be treated by traditional control methods including chemical insecticides.

The Maryland Gypsy Moth IPM Pilot Project has been actively involved in the release of parasites both as an individual suppression tactic and in combination with other tactics to maintain gypsy moth populations at low levels. In 1984, inoculative releases of Cotesia melanoscelus (Korean strain) and Glyptapanteles flavicoxis were made at several locations within the project treatment area. Also, releases of C. melanoscelus were made following aerial application of Bacillus thuringiensis at two locations. In 1985, inoculative releases were made with C. melanoscelus (Korean strain) and Rogas lymantriae. Inundative releases of C. melanoscelus (Korean strain) at 10,000 females/acre were made at 6 sites within the project area. Also, C. melanoscelus (Korean strain) adults were released following B. t. application at one location within the project area.

For more information about the Maryland IPM Program contact: Maryland Department of Agriculture, 50 Harry S. Truman Parkway, Annapolis, MD.

* THE GYPSY MOTH ENVIRONMENTAL IMPACT STATEMENT AND ITS COURTCASE *
- Background and Update -

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Here is a summary of where things stand in court regarding the gypsy moth environmental impact statement (EIS), and how we got there. The current litigation was originally filed in April of 1982 as an injunctive action based upon alleged violations of the National Environmental Policy Act (NEPA) and the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). The plaintiffs challenged the adequacy of the USDA Programmatic EIS issued in 1981, as well as the environmental assessment (EA) prepared for a proposed cooperative USDA/State aerial spraying project with the insecticide carbaryl for eradication of a gypsy moth infestation in South Salem, Oregon. While the District Court ruled in favor of the Government, the Ninth Circuit Court, on appeal, held for the plaintiffs. That Court ruled that the environmental documents prepared were not sufficiently site-specific, and did not adequately address the human health risks associated with direct spraying of residential areas. Oregon Environmental Council v. Kunzman et al., 714 F. 2d901 (9th Cir.

1983). The Court emphasized that one agency cannot rely upon another agency's evaluation of pesticide safety. In other words, because a pesticide is registered by EPA, does not mean that it is safe. Therefore, users (agencies) are required to conduct their own evaluation of a pesticide's safety and not rely on EPA's registration.

In the fall of 1983, the USDA Forest Service and APHIS began working on a new EIS to address the court's concerns. A draft EIS was completed and made available for public review on January 6, 1984. Several weeks later, on January 26, 1984, the U.S. District Court for the District of Oregon, in response to the Ninth Circuit Court's ruling, enjoined USDA "from implementing any program for aerial broadcast spraying of carbaryl in populated areas in Oregon until they prepare a legally adequate environmental impact statement which fully discusses the risks, effects, and benefits of such a program". In effect, the court retained jurisdiction to review a new EIS before any action is taken to implement any such Federal-State cooperative program.

While all this was going on, the Ninth Circuit was also busy reviewing several other pesticide-related cases. In one judgement on a herbicide case issued about December 1983, the Court ruled that the existing data gaps and scientific uncertainties with regard to human safety, were relevant for making a reasoned choice among the alternatives, and that a worst case analysis was therefore required. Given this ruling, the Forest Service and APHIS decided to prepare a Risk Analysis using worst case assumptions which expanded upon the discussions in the Draft EIS of the human health risk associated with the use of acephate, carbaryl, diflubenzuron and trichlorfon. The risk analysis was published in Appendix F of the 1984 Final EIS, and was circulated for public comment before a Record of Decision was signed for the 1984 Final EIS.

During the summer of 1984, new information about the chemical insecticides was made available and additional comments on the risk analysis were received. This prompted the agencies to supplement the 1984 EIS. The Supplement entailed a major rewrite and a significant expansion of the risk analysis. In this endeavor, and in an unbiased attempt to be procedurally, conceptually, and scientifically correct, the Forest Service and APHIS sought outside review and comment on the risk analysis from 7 experts in various fields of toxicology and risk analysis (see page 81, FEIS as Supplemented - 1985). The supplemental document, referred to as the Final EIS as Supplemented - 1985, was available for a 45 day public review and comment period while in draft form, before being finalized and published in March 1985.

On April 15-18, 1985 USDA defended the new EIS in the US District Court for the District of Oregon. The plaintiff raised 10 substantive challenges to the EIS and risk analysis. These were: 1) No comment period for WCA (worst case analysis); 2) carcinogenicity of diflubenzuron; 3) children and chemically sensitive individuals; 4) synergistic and cumulative effects; 5) absorption and persistence rates; 6) use of ADIs and NOELs; 7) data gaps; 8) alternatives buried; 9) no estimation of total cancer victims; and 10) clarity of the FEIS.

On April 26 and May 20, 1985, the Court issued a ruling. On challanges 1-9, the Court ruled in favor of the Government. On challenge #10, clarity of the FEIS, the Court ruled for the plaintiffs. As a result, the Court issued an immediate injunction against the aerial application of acphate, carbaryl, diflubenzuron, and trichlorfon for control of gypsy moth in Oregon, with a nationwide injunction effective January 1, 1986.

The ruling is an interesting one because the Court found that the text of the FEIS (pp. i-78) does meet the plain language requirements set forth in the Council of Environmental Quality regulations for implementing NEPA. The rub comes in applying the plain language requirements to appendices and an EIS (in our case Appendix F). The Court ruled that the "worst case analysis contained in Appendix F of the FEIS is hypertechnical, complex, and replete with lengthy equations and calculations" and therefore, does not meet the clear language requirement. The Court did, however, recognize that the worst case analysis contained all the necessary information. The bottom line is that the Court ruled that the main text of the FEIS is legally sufficient, but the worst case analysis (Appendix F) is legally insufficient.

There are several options that could be exercised, ranging from a simple editorial rewrite to a major revision of the EIS. Where do we go from here? The Forest Service and APHIS are now deciding on the appropriate remedy to address the Court's ruling. Further updates on this problem will appear in subsequent issues of Gypsy Moth News.